Foreword

National
Oceanic and
Atmospheric
Administration

U.S.
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COMMERCE

NOAA Fisheries Service
Northeast Cooperative Research Partners Program

The National Marine Fisheries Service (NOAA Fisheries Service), Northeast Cooperative Research Partners Program (NCRPP) was initiated in 1999. The goals of this program are to enhance the data upon which fishery management decisions are made as well as to improve communication and collaboration among commercial fishery participants, scientists and fishery managers. NOAA Fisheries Service works in close collaboration with the New England Fishery Management Council's Research Steering Committee to set research priorities to meet management information needs.

Fishery management is, by nature, a multiple year endeavor which requires a time series of fishery dependent and independent information. Additionally, there are needs for immediate short-term biological, oceanographic, social, economic and habitat information to help resolve fishery management issues. Thus, the program established two avenues to pursue cooperative research through longer and short-term projects. First, short-term research projects are funded annually through competitive contracts. Second, three longer-term collaborative research projects were developed. These projects include: 1) a pilot study fleet (fishery dependent data); 2) a pilot industry based survey (fishery independent data); and 3) groundfish tagging (stock structure, movements and mixing, and biological data).

> First, a number of short-term research projects have been developed to work primarily on commercial fishing gear modifications, improve selectivity of catch on directed species, reduce bycatch, and study habitat reactions to mobile and fixed fishing gear.
>
> Second, two cooperative research fleets have been established to collect detailed fishery dependent and independent information from commercial fishing vessels. The original concept, developed by the Canadians, referred to these as "sentinel fleets". In the New England groundfish setting it is more appropriate to consider two industry research fleets. A pilot industry-based survey fleet (fishery independent) and a pilot commercial study fleet (fishery dependent) have been developed.
>
> Additionally, extensive tagging programs are being conducted on a number of groundfish species to collect information on migrations and movements of fish, identify localized or subregional stocks, and collect biological and demographic information on these species.

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Expanding the Use of the Sweepless Raised Footrope Trawl in Small-Mesh Whiting Fisheries

NOAA/NMFS Cooperative Research Partners Initiative
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Final Report

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Abstract
The purpose of this study was to monitor the exempted small-mesh raised-footrope trawl (RFT) fishery using data collected by sea samplers, and to improve adoption of the sweepless RFT (SRFT) through net modification at sea and production of a video. Eighteen trips were conducted from September 13 – December 19, 2002; 7 trips in which the standard whiting RFT or a raised footrope Scottish seine were used and eight trips in which the SRFT design was used. Three trips were conducted in which nets were modified at-sea from a standard RFT to the SRFT (changeovers). Biological data (catch composition, catch and discard rates, and length frequencies of whiting and regulated groundfish species) were collected during sea-sampling as part of short and long-term monitoring. Monitoring of the fishery resulted in redirection of effort away from cod concentrations, and more uniform bycatch regulations.

Efforts to improve adoption through outreach were successful. Changeover trips helped convince two of three fishermen to use the sweepless RFT. An edited video distributed to all fishery participants received positive feedback. Also, net mensuration data showed that the sweepless net appeared stable during fishing, although more measurements under varying towing conditions would be helpful to achieve optimum performance of this design.

Separate analysis of catch data verified low bycatch with all three gears observed, although data were limited and non-random and should be interpreted with caution. Additionally, catches of vessels that underwent net modifications (changeovers) appeared to perform comparably to vessels that fished the standard RFT and sweepless RFT, although adjustments in the form of headrope extensions were required.

Overall, results from this study support the SRFT as a viable option to the RFT. These preliminary results suggest that both designs can benefit the rebuilding of groundfish stocks while sustaining small-mesh trawl fisheries. It is recommended that further research and monitoring of these two gear types be conducted to further improve these designs and continue to verify low overall bycatch levels.

Introduction
Federal regulations implemented in 1994 prohibited small-mesh trawls in the southern Gulf of Maine and in Cape Cod Bay to protect juvenile groundfish species. Although these regulations allowed some small-mesh fisheries to be exempted from mesh requirements if bycatch levels were low (NEFMC 2000), trawling for whiting *Merluccius bilinearis* in Cape Cod Bay was not allowed, based on evidence of high by-catch rates during 1992-1994 (McKiernan et al. 1996).

These prohibitions had a severe impact on fishing fleets from Gloucester, Chatham, and Provincetown, Massachusetts that relied on small-mesh trawls to target whiting, red hake *Urophycis chuss*, and other species. Although Cape Cod Bay is managed under Commonwealth jurisdiction, nearly all trawlers hold Federal permits and are subject to Federal regulations. Therefore, Massachusetts fishermen could not fish with small-mesh trawls in Cape Cod Bay (McKiernan et al. 1998, 1999).

The Division of Marine Fisheries (DMF) began in 1989 to investigate this fishery and to develop gear-based solutions to high bycatch levels (Pierce and McKiernan 1990; Pol 2003). Specifically, the goal of that research was to decrease bycatch of regulated species (Atlantic cod *Gadus morhua*, witch flounder *Glyptocephalus cynoglossus*, American plaice *Hippoglossoides platessoides*, yellowtail flounder *Limanda ferruginea*, haddock

Melanogrammus aeglefinus, pollock *Pollachius virens*, winter flounder *Pseudopleuronectes americanus*, windowpane flounder *Scophthalmus aquosus*, redfish *Sebastes fasciatus*, and white hake *Urophycis tenuis*). Trials involving a trouser-trawl fitted with a removable horizontal separator panel determined that optimum catches of whiting could be obtained with a 90% reduction of regulated flatfish species at a height of 1-2 feet (0.5 m) off the bottom (Carr and Caruso 1993). This result inspired Robert Bruce, a former draggerman working for DMF, to develop the raised footrope trawl (RFT), a net that fishes 1-2 feet off the bottom. Reportedly, this design was adapted from a shrimp trawl used on the US Northwest coast (Richard Taylor, pers. comm.).

Additionally, a separator grate, based on the Nordmøre shrimp grate, was tested during a limited experimental fishery from 1995 – 1997 by the Maine Department of Marine Resources. This device was eventually adopted for small-mesh whiting fisheries in the northern Gulf of Maine. Although results indicated a substantial reduction in regulated species, the grate was never popular with Massachusetts fishermen in part because large (or “king” (> 12 in (30.5 cm))) whiting were excluded by the grate along with regulated species (Amaru 1996).

Results using the RFT were promising. Initial testing of the RFT in 1995 on one vessel resulted in catches of regulated groundfish species that comprised less than 5% of the total (McKiernan and King 1996; McKiernan et al. 1996). In spring 1997, extensive paired tows comparing the RFT to a standard small-mesh whiting net demonstrated that the RFT could reduce catch of regulated species by 70% and of regulated flatfish by 83% with no significant reduction in whiting catch (DMF, unpubl. data).

RFT design and modifications (including a sweepless version of the RFT) were also tested in a flume tank in Newfoundland, Canada by DMF in March 1998. Flume tank testing was used to refine the RFT (and sweepless RFT), and to define the exact rigging necessary for the design to fish cleanly. The key to the effectiveness of the RFT is the height of the footrope off the bottom. By raising the footrope 1-2 feet above the bottom, the net exploits differences in habitat preferences and swimming behaviors between target and non-target species. At this height, the RFT retains whiting and red hake that swim above the substrate, while passing over non-target species such as flatfish that stay close to the bottom. To raise the footrope, a chain sweep longer than the footrope is attached to the footrope using “drop chains” that are 42 inches (1 m) long (Figure 1a). The weight of the chain keeps the trawl mouth open while the drop chains allow the footrope (fishing line) to fish 1 – 2 feet off the bottom. The sweep is longer than the footrope to prevent it acting as a “tickler chain” and thereby encouraging demersal species to enter the net. A fuller description of the RFT is provided by NEFMC (2000).

One notable and useful characteristic of the RFT was that it could easily be applied to almost any net design (that otherwise fit the regulations). Because only the ground gear, headrope and footrope are affected, the RFT is a modification that can be applied to two and four seam nets, and even three bridle nets and Scottish seines. No changes to webbing or codends are necessary. Consequently, while the regulations are specific about the rigging of the sweep and other aspects of the forward part of the net, they are not specific about the net design. This flexibility has resulted in a wide diversity from vessel-to-vessel in the design of their individual “whiting nets.”

Modifications of the RFT continued to be tested. A sweepless design (Figure 1b), which is identical to the RFT (except that the chain sweep is removed and the dropper chains are made heavier) was flume tank tested (Figure 2) and field tested in the 1998 fishery (McKiernan et al. 1999) on a limited basis. In 1999, field testing of the sweepless trawl continued and demonstrated that the sweepless trawl was a viable alternative to the RFT. However, comparisons of catch rates of whiting and red hake were inconclusive (Pol 2000). Power analysis showed that the number of tows necessary to detect true differences was unreasonably high (Pol 2000).

DMF's RFT research efforts culminated in Framework Adjustment 35 to the Northeast Multispecies Fishery Management Plan (Multispecies Plan) (NEFMC 2000). Framework 35 created an exempted whiting fishery in Upper Cape Cod Bay and southern Stellwagen Bank (UCC). The New England Fishery Management Council (NEFMC) and the National Marine Fisheries Service (NMFS) approved this exemption based on observed bycatch levels below 5% for 111 of 130 observed trips. Under Framework 35, the use of the raised footrope trawl (RFT) or the sweepless RFT was mandated in the Provincetown-area exempted whiting fishery.

The seasonal RFT whiting fishery in upper Cape Cod Bay thus joined two other small-mesh whiting exempted fisheries off New England. The Cultivator Shoal fishery was established in the early 1990's under an earlier exemption program, and was continued after the passage of Amendment 5 to the Multispecies Plan (NEFMC 2000). The Ipswich Bay (Area I) and Jeffries Ledge (Area II) fisheries were established in 1994. The new RFT fishery was the first exempted fishery established based on an experimental fishery conducted by a conservation engineering program. The different origins of these fisheries contributed to differences in bycatch retention limits. For example, monkfish *Lophius americanus* and lobster *Homarus americanus* could be retained, within limits, when fishing in Areas I, II and on Cultivator Shoals. No retention of these species was permitted in the new RFT fishery. The differences in the bycatch allowance for different regions in effect at the beginning of this study are summarized in Table 1.

The successful creation of an exempted RFT whiting fishery was the result of more than nine years of testing (Pol 2003). Over that time, the RFT gained acceptance throughout the fleet, partly because its use was mandatory and partly because reductions in bycatch were dramatic. Additionally, DMF conducted substantial outreach by working with individual vessels. While the RFT is a popular and successful net design, several problems arose that led DMF to prefer the sweepless version.

The RFT, although relatively simple in design, can be difficult to rig and to enforce because the regulations implementing it are numerous and detailed (see Table 2 for specifications). This specificity was determined during flume tank testing to be necessary to ensure the net fished cleanly. However, this complexity also makes the net difficult to enforce. For example, measuring the length of the sweep chain requires having the net run down onto the deck and the help of another person; this level of effort hinders enforcement. The SRFT represents an improvement because it eliminates the sweep chain, which can be easily adjusted to act as a tickler chain and increase bycatch. Also, the shine produced by bottom contact on the drop chains of the SRFT can be used to indicate the approximate height of the footrope off bottom as an initial simple enforcement step.

In addition, the RFT can get hung up on ghost fishing gear or other debris, causing the net to fish closer to the bottom and incur higher bycatch. In fact, many of the tows and trips with bycatch levels above 5% during field testing were the result of interaction with other gear. Eliminating the sweep chain appears to reduce or eliminate hang-ups, based on reports from fishermen. Finally, the SRFT has less bottom contact than the RFT, and presumably less bottom impact. For these reasons, DMF sought to encourage voluntary industry adoption of the sweepless RFT.

DMF conducted several forms of outreach to encourage use of the sweepless net prior to this study. Conservation Engineering personnel offered gear inspections, presented results from fishermen who used the sweepless net, and displayed raw footage of net testing. While both versions of the RFT were written into the exempted fishery, interest in and adoption of the sweepless version remained rare. DMF's experience with video presentations has shown that a video extolling the virtues of the sweepless net might be effective and persuasive.

Objectives

At the time of the grant application, an experimental fishery along the eastern coast of Cape Cod was in existence and was intended to expand the boundaries of the Upper Cape Cod Bay fishery established by Framework 35. To augment DMF monitoring resources, and to encourage the use of the sweepless net, DMF developed a dual-purpose project that was funded by NMFS Cooperative Research Partners Initiative (CRPI). The initial objectives of this project were to monitor in "real-time" the small-mesh experimental raised-footrope trawl fishery in waters east of Cape Cod, and to improve adoption of the sweepless RFT in both the experimental fishery and the exempted Seasonal Whiting RFT Fishery. The experimental fishery was not implemented, and a formal request was submitted to NEFMC to open the area east of Cape Cod as an exempted fishery. Consequently, the experimental fishery was not opened during September and October of 2002. As DMF and fishermen awaited the approval of the exempted fishery, DMF requested a revision to the goals and objectives of the project, which was subsequently approved by NMFS. The revised goals were to monitor the exempted small-mesh RFT fishery, and to improve adoption of the sweepless RFT through net modifications at sea (changeovers) and the production and distribution of a video describing the benefits of the sweepless RFT.

Methods

The exempted fishery was monitored "real-time" (during the fishery) by deployment of DMF sea samplers on participating vessels. Additional information was obtained from routine sea-sampling by NMFS observers (although these trips were not supported by the funding from this grant.) Analysis of RFT and SRFT whiting catches was conducted because data comparing these two gear types are limited. This analysis was not an objective of this project; therefore these results are presented separately in Appendix A.

Sea sampling was conducted during the exempted whiting fishery (September 1 – November 20, 2002) in upper Cape Cod Bay and southern Stellwagen Bank (UCC), and in Ipswich Bay (Area I). Monitoring also occurred during the exempted whiting fishery (November 21 – December 31, 2002) in waters east of Cape Cod. Sampling was performed on vessels hailing from Chatham, Gloucester, Provincetown and Scituate, Massachusetts.

Sea sampling was carried out predominately following protocols established by the NMFS-NEFSC observer program (NEFSC Fisheries Sampling Branch 2004). Sea samplers selected vessels opportunistically in the whiting fleet, collected catch information on landings and discards, length frequencies of whiting and certain bycatch species, tow location, duration, depth, net characteristics and other conditions.

The second goal of this study was to encourage fishermen to adopt the sweepless RFT. Adoption of the sweepless RFT was encouraged in two ways: "changeover" trips, and the production of a videotape. The purpose of "changeover" trips was to encourage adoption of the sweepless design through direct demonstration by re-rigging and tuning a vessel's net during fishing operations. A contracted fisherman (who has demonstrated proficiency using the sweepless RFT) performed the gear modifications while at sea on the participating vessel, accompanied by DMF personnel. The RFT that belonged to the vessel was re-rigged by the contracted fisherman into an SRFT. Re-rigging consisted of severing the sweep chain from the drop chains by cutting chain links or removing shackles and then hanging an additional 42-in chain at each attachment point.[1] Additional weight was found in the flume tank to be necessary to keep the footrope at the right height. One other primary modification was made: if high bycatch levels were observed, extensions ((1, 1.5, 2.0 ft) (0.3, 0.5, or 0.6 m)) were added to the end of each top wing to increase headrope length (Figure 3). Extensions would therefore increase headrope length twice the length of the extension and raise the footrope further off the bottom. Other adjustments were made based on the contracted fisherman's experience. Catches were monitored and recorded (using the same sampling protocol) by tow on these trips also.

Letters (Appendix B) were sent to 33 previous fishery participants (Appendix C) explaining the project and soliciting interest. Vessels were offered a small amount of compensation for lost income due to reduced fishing time during the trip. Trips were arranged with vessels from Gloucester, Provincetown and Scituate.

An edited video documenting at-sea modifications of the RFT was produced. Filming was performed on vessels hailing from Gloucester and Provincetown. Trawl nets were deployed using an underwater video camera attached to the headrope with live feed to a monitor inside the vessel's wheelhouse. Footage of whiting and other species interactions to the trawl were observed and recorded. Additionally, remote sensors were attached to trawl doors, headrope and wings to record data on net geometry. Information on door spread, wing end spread, and headrope- and footrope height were recorded by sensors and transmitted to a wheelhouse computer.

Net mensuration data collected from Netmind software were recorded into Excel spreadsheets and audited to exclude outlier measurements (periods where accurate net geometry measurements were not obtained). In addition to net mensuration parameters collected, distances between headrope and footrope were calculated for each tow. To measure the distance between footrope and the seafloor, data measuring headrope height from the seafloor and distance between headrope and footrope were audited and cross-referenced based on the time in which the data point was collected for both parameters. Differences were generated for each pair of data points and basic statistical variables (mean, variance, standard deviation, standard error and 95% confidence limits) were calculated for each parameter measured.

Results

Eighteen trips (50 tows, 88 hours towing) were observed by DMF (N = 15) and NMFS (N = 3) personnel on vessels targeting whiting (all gear and trip types combined) from September 13 – December 19, 2002 (Table 3). Fifteen trips were observed in Upper Cape Cod Bay and two trips were observed in Area I (Ipswich Bay) (Table 4). One trip (3 tows) was observed in the

[1] The maximum size drop chain stock when used with a sweep is 5/16-inch. Drop chains may be a maximum of 3/8-inch stock when no sweep is used. Hanging two 5/16-in chains is also common when using the SRFT.

small-mesh exempted area east of Cape Cod which was opened from November 21 – December 31, 2002. As observed in previous years, additional trips were limited by adverse weather conditions in the months of November and December as well as the size of vessels in the fleet (larger vessels being able to tolerate more severe weather): seven additional trips were attempted but prevented by weather. Catch composition is summarized in Table 4. Whiting (44,978 lb (20,402 kg)) dominated the total catch, whereas total catch of regulated species (2,846 lb (1,291 kg)) accounted for 3% of the total catch (92,724 lb (42,059 kg)).

Selection of vessels was opportunistic and was not representative of the fleet as a whole (Table 3) and net size and type and codend mesh size varied from vessel to vessel. The fifteen trips conducted under this study by DMF consisted of 6 sea sampling trips onboard vessels using the standard RFT, 5 onboard vessels using the sweepless RFT, 3 trips onboard vessels undergoing modifications (changeovers), and 1 trip onboard a Scottish seine vessel. The three trips conducted by NMFS observers were performed onboard vessels using standard RFT. Total catch weights for all observed trips are presented in Table 4. CPUE is presented in the separate analysis (Appendix A).

One trip was conducted onboard a Scottish seine fishing vessel in the small-mesh exempted area east of Cape Cod on December 19, 2002. Scottish seiners use a net similar in shape and design to an otter trawl; however, in Scottish seining the net is set in the water and slowly hauled to the boat, without the use of trawl doors (Sainsbury 1971). Three tows were conducted for 4.5 hours of fishing time. Whiting (840 lbs (381 kg)) dominated the catch with regulated species (30 lbs (14 kg)) comprising 3.1% by weight of the total catch.

Three vessels (one each from Gloucester, Provincetown and Scituate) participated in changeover trips. Two trips were conducted in upper Cape Cod Bay; one trip was prosecuted in Area 1. Total landings and discards for changeover trips are separately summarized in Table 5. Whiting (5,438 lb caught; 5,238 lb landed) dominated the total catch. Total catch of regulated species (362 lb) constituted 3.7% of the total catch (9,912 lb). Catch results by tow for changeover trips are analyzed and described in Appendix A.

Filming was limited by weather conditions and water clarity. Two filming trips, during which 5 tows were performed, were conducted on October 9 and 10, 2002. One tow was filmed and measured with the sweepless RFT without added extensions, two tows were filmed after insertion of 1 ft extensions on either end of the headrope, one tow using 1.5 ft extensions, and one tow using 2 ft extensions. Net mensuration data were collected during these two filming trips. Measurements of headrope height, footrope height, wing spread and door spread for each modification are summarized in Table 6, and shown in Figure 5. Mean height (± SE) from seafloor was lowest during the two tows when the 1-ft extension was added (9 October) (0.26 ± 0.2 ft (0.08 ± 0.06 m) (N_{obs} = 20) and 1.44 ± 0.52 ft (0.44 ± 0.16 m) (N_{obs} = 26)). For the rigging without extensions (10 October), the footrope was further off the bottom (6.8 ± 0.36 ft (2.07 ± 0.11 m), N_{obs} = 101). The addition of the 1.5 and 2-ft extensions (10 October) raised the footrope further, to 8.4 ± 0.36 ft (2.56 ± 0.11 m) (N_{obs} = 112) and 8.63 ± 0.36 ft (2.63 ± 0.11 m) (N_{obs} = 114).

A 12 minute video tape (Szymanski 2003) was produced and distributed to 67 participants in the 2002 whiting fishery and other interested parties, including the New England Fishery Management Council (Appendix D, E). Footage collected from both sea-sampling trips, and scale-model testing at the flume tank from the Marine Institute at Memorial University in Newfoundland, show how this net design became management's new tool and helped re-establish the whiting fishery. The video starts with a historical account of the importance of the whiting fishery for Massachusetts small fishing vessels, the reasons why the fishery was closed, and the re-opening of this fishery in the advent of the standard RFT. The video then discusses advantages of a sweepless RFT over a standard RFT. The source for the regulations surrounding small mesh fishery exemptions was also presented. The end of the video shows the potential of the improved design in other fisheries. This video is catalogued in the DMF Conservation Engineering Program's video library as 03MADMF845.

Discussion

Monitoring of the fishery had both short- and long-term effects. For example, sea sampling was used during the project (11/4/02) to redirect effort from the top of Stellwagen Bank to avoid high cod bycatch, meeting one of our objectives (Table 4). This redirection helped keep the overall percentage of regulated species bycatch for all observed trips during the 2002 season low (< 5%) (Appendix A).

A long-term effect resulting from monitoring of the fishery was a change in the bycatch regulations for Areas I and II. The trip in the Area I fishery on 13-14 September highlighted differences in lobster and monkfish possession limits between exempted small-mesh fisheries (Table 1). In DMF's view, these differences in possession limits provided an incentive for fishermen to rig the RFT improperly to increase bottom contact, and increase the catch of these bottom-tending organisms. This trip provided evidence that improper rigging was taking place in this area to capitalize on the bycatch allowance. DMF contacted NEFMC staff to rectify the inconsistencies between bycatch limits in different small-mesh whiting areas. Consequently, uniform bycatch allowances were proposed through Framework 38 (NEFMC 2003).

The substantial number of observer trips that were conducted also allowed monitoring of the exempted fishery in a longer term, by comparing the level of bycatch of regulated species (Appendix A). Tremendous effort is often put into establishing the effectiveness of a gear modification; however, measurements of its effectiveness once widely implemented are rare. This overall "fleet selectivity" expresses the fleet's geographical and seasonal utilization of the gear (Danish Institute for Fisheries Research 2003) and the resulting variability. This study offered an opportunity to quantify the effectiveness of the RFT and sweepless RFT on a variety of vessels under true fishing conditions, and not in the context of an experiment.

This project was not designed as a gear comparison, so caution must be used when interpreting results of the limited catch analysis presented in Appendix A. Overall, the measured fleet selectivity was low, closely matching experimental results. Bycatch levels of regulated species from this fishery, compared to sea sampling data from previous years (McKiernan et. al. 1998, 1999, NEFMC 2000), continue to remain low (3% (this study) v. 3% (1999)). These results are consistent with or better than those measured in the years of the experimental fishery and indicate the exempted fishery is in good condition in terms of avoiding bycatch. A further investigation of the whiting fleet selectivity (the bycatch levels in the exempted fishery) is currently underway using a combination of sea sampling data and vessel logs by DMF as a separate project.

The presence of cod was responsible, in one trip (11/4/02), for bycatch levels above 5% in individual tows using the sweepless RFT. The occurrence of high cod bycatch on individual tows has been observed in previous years as well, and further demonstrates that although the sweepless and standard RFT are effective in reducing bycatch levels of regulated flatfish species, they do not minimize the bycatch of cod. In fact, results from paired testing of the

RFT and a standard net showed no effect on the catch of cod (DMF, unpublished data). This lack of effect was taken into consideration in establishment of the exempted fishery by closing the fishery before the seasonal arrival of cod on Stellwagen Bank.

Large-mesh nets are being developed that avoid cod in flatfish fisheries. We have observed a rising behavior of cod as they are overtaken by the trawl, where they ascend above the footrope and are caught. Possible net modifications to reduce cod catches include avoiding areas where cod are present or further net modifications such as large square-mesh panels in the tops of nets or removing the top panels in nets (thereby moving the headrope further back in the trawl).

As conservation measures result in increasing numbers of cod in the Gulf of Maine, cod bycatch may become more prevalent in small-mesh fisheries. However, our observations that the RFT and SRFT continue to have low overall bycatch bodes well for this fishery. Proposed fishery regulations have recently required periodic renewal of exempted fisheries. If bycatch levels observed here continue, the exempted RFT fishery should be sustained.

Net mensuration data verified that insertion of extensions increased footrope height. However, results also showed an unexplained difference in net performance. The same net on the same vessel was measured on consecutive days, carrying both mensuration sensors and film equipment. Unexpectedly, headrope and footrope height were significantly lower on the first day than on the second, despite the use of 0.3 m extensions on the first day. Insertion of longer extensions on the second day did increase the footrope height although the measured heights (over six feet from headrope to seafloor) were much greater than expected for every configuration: no extensions; 1.5 ft and 2.0 ft extensions. Camera footage and logs supported the mensuration data; on film, the net can be seen to be higher than 1-2 ft off bottom. Despite this height, various species of fish can still be seen entering the net.

The rigging of the net was identical from the first day to the next. Although the reason for the change in height cannot be identified, the headrope and footrope heights observed on the second day should be considered anomalies, and not indicative of a failure of the sweepless design. Flume tank testing, the shine on the drop chains, and its popularity with some fishermen all demonstrate that the sweepless design is effective. Tidal currents may have influenced net height; they can increase or decrease a net’s speed over ground and therefore its headrope and footrope height. Measurements of tide were not recorded on this day. It may be possible that the electrical cable connecting the camera to its winch was tighter on the second day, providing additional lift to the net. Further, the performance of the sensors over different bottom types may create erroneous readings. It appears imperative that further examination of variation in net performance, and verification of net mensuration equipment, be conducted to understand the factors affecting headrope and footrope height.

Use of the extensions on the headrope did have a noticeable effect on catch on a couple of tows (Appendix A). In one case, use of an extension resulted in elevated bycatch. On a changeover trip conducted on November 1, 2002, extensions were added to the headrope of the net with the purpose of raising the footrope off the bottom. However, increased levels of flatfish and lobsters were observed in the tow, the opposite of the result expected. On another trip (10/24/02), extensions were added to the lower legs of the sweepless RFT, the opposite of the usual practice, to demonstrate both the effect of the insertion as well as the results of fishing the footrope closer to the seafloor. The presence of mud and a lobster trap and increased volumes of skates, flatfish, monkfish and lobster were observed in the catch presumably as a result of this modification. The combination of mensuration data and some catch results indicates both that the use of extensions can have an impact on the net, and that other small adjustments may be needed to optimize net performance. The catch and mensuration results emphasize the need for tuning and for further underwater at sea measurement of nets, as the number of observations under this study was very small and the results unexpected.

The small confidence intervals observed in the measurement data indicate that while headrope height may vary from day to day, the net shape during individual tows remained stable at towing speed ranging from 2.5 – 3.1 knots. Questions have been raised about the impact of towing speed on bycatch. Flume tank testing indicated a trend of increasing footrope height and decreasing headrope height with increasing speed (DMF, unpubl. data). The flume tank data suggested that towing below 2.5 knots may result in lower footrope heights and therefore higher bycatch. At least two factors might inhibit slower towing during the fishery: risk of damage to the footrope from bottom contact; and stalling of the trawl doors resulting in a collapsed net. To accurately determine the effect of slower speeds on footrope height, further net mensuration of this design should be conducted under varying speeds. Overall, however, we did not observe any results to discount the assumption that the sweepless RFT performs acceptably compared to the standard RFT, and that the sweepless net continues to have the advantages of simplicity of rigging, enforcement, and lower susceptibility to entanglement.

The primary purpose of the changeover trips and the production of the video were focused on encouraging voluntary adoption of the sweepless RFT. Two of the vessels which participated in the changeover trips plan to use the sweepless RFT during the 2003 fishing season, an encouraging sign. One vessel’s crew simply rejected the sweepless design, and the captain acceded to their choice. Further participation was limited both by lack of response, and because of weather and the delay in opening of the Chatham area fishery. As the distribution of the video occurred between whiting seasons, we cannot measure its impact yet. However, early responses from fishermen have been favorable.

The sweepless net design has been popular with gear scientists. A portion of the video was displayed at a recent international meeting of gear scientists during a presentation on the reduced bottom impact of this gear (Pol et al. 2004). This viewing has resulted in over 15 requests for a copy of the video. Also, the activities of this study, and other results, prompted Maine DMR to propose an exempted fishery for whiting along the Maine coast, using the SRFT in conjunction with a Nordmøre grate. This response and those of scientists at the recent gear meeting illustrates that this design and the outreach associated with this project have been successful in encouraging its use among the scientific and regulatory community.

DMF’s strategy for the SRFT will continue to be to work cooperatively with fishermen in a manner that encourages them to adopt gear modifications voluntarily before, or instead of, incorporating them into regulations. If DMF seeks eventually to mandate the use of the sweepless net, the cooperative work funded by this project will encourage compliance because fishermen will have been introduced to the sweepless net before it was required.

Future Research

Future work with the sweepless RFT must include at-sea demonstration and tuning, as well as continued measurement of net geometry and calibration of net sensors. We believe that demonstration of the practical use of this lower-impact gear will continue to be essential to further industry acceptance of the sweepless RFT.

One modification we propose testing is the addition of cookies to the ground cables (Pol et al. 2003). The regulations for the RFT are very specific, limiting ground cables to “all bare wire not larger than ¾-inch diameter” (NEFMC 2000). However, fishermen allege that this restriction makes fishing in areas with mud bottom difficult because the bare wire digs into the mud, thereby causing the net to fill with mud and fish closer to the bottom. The addition of cookies (1.5 – 2 inch diameter rubber discs) makes the ground cable much less likely to dig into mud, allowing whiting to be caught cleanly in areas of mud bottom.

Further improvement of the RFT is important because the northern stock of whiting is fully rebuilt (NEFMC 2003) and offers opportunity for redirection of groundfishing effort. The proposed research seeks to keep the fishermen safer and their catch even cleaner than earlier versions of the RFT.

Also, DMF plans to make the sweepless design an essential feature of a haddock-specific trawl currently in the process of development (Moth-Poulsen et al. 2003). The reduced bottom contact of the sweepless net makes its potential use in sensitive habitat areas more likely.

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References

Amaru, W.H. 1996. A size-selective, near-zero mortality trawl for silver hake. Saltonstall-Kennedy Report NA66FD0011. National Marine Fisheries Service.

Carr, H.A., and P. Caruso. 1993. Application of a horizontal separating panel to reduce bycatch in the small mesh whiting fishery. Proceedings of the Marine Technology Society Global Ocean Partnership Conference. Oct. 19 – 21. Washington D.C. p. 401 – 407.

Danish Institute for Fisheries Research. 2003 (accessed). DIFRES Strategy 2005. http://www.dfu.min.dk/uk/Publications/Strategy%202005.pdf. 22 pp.

McKiernan, D.J., and J. King. 1996. Analysis of Sea Sampling Results from Trawlers Fishing in Small-Mesh Area I (Ipswich Bay) During July – November 1995. A Report to the National Marine Fisheries Service. March 19, 1996. 17 pp.

McKiernan, D.J., J. King, H.A. Carr, and J. Harris. 1996. Final report on the fall 1995 small-mesh experimental silver hake fishery in Cape Cod Bay employing a DMF raised footrope bottom trawl. A Report to the National Marine Fisheries Service. April 2, 1996. 8pp.

McKiernan, D., R. Johnston, B. Hoffman, A. Carr, H. Milliken, D. McCarron. 1998. Southern Gulf of Maine Raised Footrope Trawl 1997 Experimental Whiting Fishery. Division of Marine Fisheries, Boston, MA.

McKiernan, D., R. Johnston, B. Hoffman, A. Carr, D. McCarron. 1999. Southern Gulf of Maine Raised Footrope Trawl Experimental Whiting Fishery. Division of Marine Fisheries, Boston, MA.

Moth-Poulsen, T., M. Pol, and B. Lane. 2003. Development of an industry- and environmentally-friendly species-selective haddock trawl without horizontal separator panels. Northeast Consortium Proposal. Submitted 14 July 2003

New England Fishery Management Council. 2000. Framework Adjustment 35 to the Northeast Multispecies Fishery Management Plan. Newburyport, MA.

New England Fishery Management Council. 2003. Framework Adjustment 38 to the Northeast Multispecies Fishery Management Plan. Newburyport, MA.

Northeast Fisheries Science Center Fisheries Sampling Branch. 2004 (accessed). Fisheries Observer Program Manual. http://www.nefsc.noaa.gov/femad/fsb/. 310 pp.

Pierce, D.E. and D. McKiernan. 1990. Report on DMF November 1989 Sea Sampling On Board Draggers Fishing in Cape Cod Bay and Lower Massachusetts Bay. Mass. Div. Mar Fish., 23 pp.

Pol, M. 2003. Turning Gear Research into Effective Management: A Case History (poster). Managing Our Nation’s Fisheries. November 13-15, 2003. Washington, DC.

Pol, M. 2000. Effect of Removal of the Chain Sweep from a Whiting Raised Footrope Trawl. Div Mar Fish Cons Eng Project Report. 7 pp.

Pol , M., J. Sheppard, and D. McKiernan 2004. Expanding the Use of the Sweepless Raised Footrope Trawl in Small-Mesh Whiting Fisheries. ICES Working Group on Fishing Technology and Fish Behavior. Gdynia, Poland, 20-23 April 2004.

Pol, M.V., T. Moth-Poulsen, and L. Ribas. 2003. The Third Generation Raised Footrope Trawl Improving Safety and Reducing Impact. Proposal to the Northeast Consortium. July 14, 2003. 17p.

Sainsbury, J. C. 1971. Commercial Fishing Methods. Fishing News (Books) Ltd, Surrey, U.K.

Szymanski, M. (producer). 2003. Expanding the Use of the Sweepless Raised Footrope Trawl in Small-Mesh Whiting Fisheries. [video] Available from Division of Marine Fisheries, Pocasset MA. 12 min.